DRAFT

FSP Addendum for Identification of Proposed Re-Randomized Sediment Grab Locations in the Downtown/Upriver Reaches, Surface Sediment Sampling FSP

Portland Harbor Superfund Site
Pre-Remedial Design Investigation and Baseline Sampling
Last revised May 23, 2018 (v4)

1.0 Introduction

This FSP Addendum presents proposed re-randomized upriver surface sediment sampling locations based on recent soft sediment probing results. Soft sediment probing data were collected in April 2018 by Geosyntec and AECOM to identify areas of high proportions of fine-grained soft sediment. This FSP addendum (1) documents the field methods used for upriver probing, (2) describes the mapping of soft sediment areas, and (3) selects randomized gridded target locations for collection of surface sediment samples in areas identified as predominantly soft sediments. The potential need for re-randomization is outlined in *Section 2.1.4 Pre-Screening D/U Sediments for Grain Size and TOC* of the Pre-Remedial Design Investigation (PDI) Surface Sediment Sampling Field Sampling Plan (FSP; AECOM and Geosyntec 2018) approved by the U.S. Environmental Protection Agency (EPA) on March 29, 2018.

As described in Section 2.1.4 of the FSP (AECOM and Geosyntec 2018), surface sediment sampling in the Downtown and Upriver Reaches (D/U Reach) will target sample locations representative of fine material (including organic carbon and colloids and silt and clay particles) that is likely to be transported downstream. Surface sediment sampling locations are developed to target samples with greater than 35% fines (sum of silt and mineral clay fractions), with total organic carbon (TOC) concentrations representative of the Site.

2.0 Field Methods

Between April 2 and 6, 2018, AECOM and Geosyntec field staff along with EPA oversight conducted a field reconnaissance survey to confirm the bottom conditions of the D/U Reaches using three tools (presented in sequential order of use):

1) BioSonar® acoustic sonar
2) Mechanical hand-probing using 18-foot-long sediment probe
3) Visual classification of sediment texture (along with field wet sieving)

The survey area extended from river mile (RM) 11.8 up to RM 26.4 (northeast and upstream of Willamette Falls). During this 1-week field survey, 15,446 BioSonar® data points were collected, 275 locations were hand-probed, and 57 visual confirmation samples were collected. The field methods and approach are described in more detail below. Figure 1 series (1a–1h) presents the sonar and probing locations.

BioSonar Acoustic Sonar

BioSonar® was conducted on the first day (April 2, 2018) to help provide spatial coverage and help identify hard-bottom areas that would be excluded from sampling. BioSonar® acoustic sonar was identified by the field team as a tool that would provide better spatial coverage of the deeper, middle-channel river areas that were beyond the reach of the hand-probe; its use was approved by EPA in Change Request 4.

BioSonar® uses a single-beam Echosounder that generates five acoustic sonar pings per second. The BioSonar® data contain information about bottom sediment substrate type (density and texture) embedded in the echo signal. Visual Habitat® software uses statistical signal processing techniques (Principal Component Analysis) to decode the signal and identify the composition of the bed material (e.g., rock, sand, and mud substrates). The BioSonar® tool also provides water depth soundings. Differential GPS (DGPS) is incorporated into the Echosounder to provide accuracy of less than 3 meters with DGPS updated every second. The sounder was located at the bow of the research vessel, and the vessel moved in sweeping transects across the river approximately every one tenth mile.

Mechanical Hand-Probing

Mechanical hand-probing was conducted from April 3 to 5, 2018, using an 18-foot-long metal probe. Probing of the sediments was performed at transects approximately every 0.1 RM but limited to areas where the water depth was less than 18 feet (primarily the eastern and western shores of the river). Along each transect, the metal probe was inserted manually through the water column into the surface sediment to classify the substrate as either soft, medium, or hard based on the probe operator's assessment of bottom substrate resistance to the probe (and confirmed with a visual ponar grab). Beyond a depth of 18 feet, sediment could not be safely assessed using the probing technique; therefore, the BioSonar® tool was used, as described above.

Visual Classification and Wet Sieving of Grab Samples

On April 6, 2018, areas were revisited where the mechanical hand-probing identified the bottom substrate as soft sediment, and grab samples were collected to verify the BioSonar® and mechanical hand-probing results. Sediment was obtained using a Ponar grab sampler deployed from the research vessel and visually classified according to the ASTM visual-soil classification method described in Appendix A-1 of the FSP.

In addition to visual classification of the sediment, field wet sieving techniques were conducted on the grab samples by the field team on the vessel deck to quantify the percent fines by volume. A 200-milliliter sample of sediment was sieved through a No. 200 sieve (74-micrometer mesh), and the volume of sediment retained on the sieve was recorded in the field notebook along with the calculated percentage of fines (Table 1).

3.0 Data Analysis

The desktop evaluation of the field reconnaissance survey data included three data analysis steps to select 60 proposed D/U Reach surface sediment sampling locations (30 in the Downtown Reach, 30 in the Upriver Reach). Step 1 included a review of the BioSonar® data to exclude large areas of hard bottom substrate from further data analysis, primarily from the middle of the channel. Step 2 included the interpolation of the remaining areas and classification of soft, medium, and hard bottom substrates based on the hand-probing, visual classification, and wet-sieving results. Step 3 included randomized placement of 60 locations in the areas identified as soft bottom with >35% fines. These steps are described in more detail below.

Step 1 – Review of BioSonar® Data and Determination of Mid-Channel Hard Bottom

The BioSonar® soundings point-data (categorized as 1, 2, 3, 4, 5, and 6 return ratings) were processed and decoded into groupings of soft, medium, and hard bottom substrates.[1] A statistical comparison was conducted between a "hard" BioSonar® return and what was classified as "hard" during the mechanical probing/visual classification to determine if the sonar data could be used to support the mapping of areas determined to be hard bottom. Figure 2 presents the correlation between BioSonar® data indicating hard bottom substrates and the average percentage of fine sediments based on results of visual grab sample confirmation and 2004 Remedial Investigation/Feasibility Study (RI/FS) data points.[2]

The BioSonar® data suggest that the middle of the channel almost exclusively features hard-bottom substrates. Multiple ponar grabs in the middle of the channel confirmed sediment generally contained less than 35% fines based on visual classification. The multiple data types evaluated (including the 2004 RI/FS data) show that the middle channel of the river generally does not contain soft sediment substrate with greater than 35% fines. Based on this conclusion, the middle channel area was excluded from further analysis in Steps 2 and 3. The hard bottom mid-channel area was delineated manually by "connecting the yellow dots" among the sonar "hard bottom" returns near the middle of the channel. The middle channel areas are unlikely to feature soft sediment with greater than 35% fines. Figure 1 series (1a–1h) presents the BioSonar® results and the mid-channel exclusion area that was generated based on the hard bottom designation. The area encompasses 37% of the D/U Reach.

Step 2 – Interpolation of Spatial Extents

Following exclusion of the middle of the river that is hard bottom under Step 1, the remaining areas were interpolated using Thiessen polygons for spatial extents. Each polygon was assigned a classification value of *soft, medium, or hard* based on the hand-probing data and visual confirmation of the probe data:

[1] The data is classified into the 6 sediment hardness classifications using an FCM (Fuzzy Centroid Mean) Algorithm.
[2] The correlations included sonar data within a 100-ft radius of a known, discrete probe or data point.

- Soft Bottom – areas identified as predominantly soft silt size fractions with easy penetration by the hand probe (then visually confirmed as containing greater than 35% fines with a grab sample).
- Medium Bottom – areas identified as medium hard substrates from the hand-probing data were generally classified as predominantly sand.
- Hard Bottom – areas where hand-probing data hit "hard" substrate, and penetration was zero or minimal, were generally classified as containing dense sand, gravel, or cobble.

Figure 3 series (3a–3h) presents the Thiessen polygons, hand-probe results, and % fines from historical surface sediment samples collected during the 2004 RI/FS for comparison. As shown in Figure 3, Thiessen polygons are located on the river margins, nearshore, and back eddy areas of the river and "clipped" to exclude the mid-channel area. The mid-channel hard-bottom area that was determined in Step 1 was used during the generation of the Thiessen polygons to prevent shoreline probe data from giving a false characterization of sediment conditions (false positive) in the middle of the river. Table 2 presents the area (in acres) of probing area, exclusion area, and remaining hard, medium, and soft sediment > 35% fines area.

Step 3- Grid Derivation and Sample Randomization

The total soft-bottom area to be sampled within the D/U Reach, as delineated by the survey efforts, consists of non-contiguous polygons spread among the length of the two reaches. Soft sediment bottom with greater than 35% fines comprises 454 acres (23%) of the D/U Reach based on the Thiessen polygons. As designated in the Work Plan (Geosyntec 2017), both the Downtown Reach (RM 11.8 to 16.6) and the Upstream Reach (RM 16.6 to 28.4) are to include 30 randomly determined sample locations for subsequent surface sediment sample collection.

Grid Derivation

To distribute these sample locations in a randomized manner such that the samples would be evenly distributed along the length of the reaches where soft sediment areas are present, a grid was generated within the soft sediment areas such that 30 cells were present in the Upstream Area and 30 cells were present in the Downtown Reach. While this step was not specifically mentioned in the surface sediment FSP, we are proposing this step because it is consistent with the grid cell approach used to randomly place surface sediment samples within the Site and to provide spatial coverage across all soft sediment areas. A grid pattern avoids potential randomization in which some portions of soft sediment in the D/U Reach areas are not sampled or are sampled at extremely high density compared to other areas of soft sediment.

To generate the grid cells, once the Thiessen polygons had been generated in Step 2, the total length of soft sediment areas was measured, and then 60 evenly spaced grids were plotted within the soft sediment areas to allow for an even distribution of randomized sample grid cells laterally along the river. The total lateral length of soft sediment areas was approximately 1,625 feet (ft): 675 ft in the downtown reach and 950 ft in the upriver area. Grid sizes were similar between the D/U Reaches, with the slight difference resulting from the higher lateral length of soft sediments in the Upriver Area.

Sample Randomization

Surface sediment sample locations were randomly generated within each of the 60 soft sediment grid cells (one location per cell) using the Create Random Points tool in ArcGIS 10. The same randomization approach and tool were used for the randomly generated stratified random surface sediment sample locations within the Site described in the Work Plan (Geosyntec 2017). Figure 4 series (4a–4h) presents the grid cells, soft sediment areas as Thiessen polygons, and proposed sediment locations (note: x/y coordinates will be provided to the field crews and EPA after the target locations have been approved by EPA). Based on this approach, the samples are randomly distributed within areas that are likely to yield samples of soft sediment with greater than 35% fines.

4.0 Results and Recommendations

The stratified random grid approach for soft sediment areas provides spatial coverage across the D/U Reaches and is consistent with the Work Plan methodology used to select the locations for the stratified random samples within the Site. Consistent with the FSP, the goal is to collect the surface sediment samples as three-point composite grab samples.

The average distance between a known probe point indicating soft sediment and a random sample location is approximately 150 feet, with a maximum distance of approximately 300 feet. Therefore, uncertainty exists regarding changes in surface sediment composition between the probed and randomly proposed location within a grid cell. For this reason, a larger sampling radius will be used. To address this uncertainty during field sampling, the field crews will:[3]

- Go to the randomized location and probe the bottom;
- If the bottom is soft, then collect a sample and conduct wet sieving;
- If wet sieve screening results show >35% fines by volume,[4] then collect a three-point composite sample within a 50 ft radius of the target location and collect the three best/deepest recovery of six bucket attempts;
- If the probing shows hard bottom, then move out up to another 100 ft and repeat the steps above; if probing still shows hard bottom then repeat the steps again up to a maximum radius of 300 ft; and
- Document field conditions, weights used, and probing/wet sieving results.

The minimum acceptable field criteria for a sample will include a one-point composite of at least 4-centimeter recovery, with visual characterization indicating greater than 35% fines (by volume). If the field crew is unable to collect an acceptable soft sediment sample with >35% fines within a reasonable radius within a grid cell, then alternate options for that grid cell will be

[3] Note that these guidelines are for optimal sample recovery. See sentence following the bullets for minimum acceptable criteria in the case of challenging field conditions.
[4] Percent fines and TOC are both needed as physical substrate facies-predictors of total PCBs concentrations upriver; neither variable is a good predictor by itself. Therefore, TOC is also needed for final selection of upriver samples for full suite chemical testing.

discussed with the Project Manager and EPA. The field crew may move to another grid cell while alternate options are being decided.

The Upriver surface sediment samples will be analyzed as described in Section 2.1.4 of the Surface Sediment FSP. All samples will first be analyzed on an expedited basis for grain size and TOC to confirm these parameters are within the criteria included in the FSP. If the grain size and TOC results are within the stated criteria in the FSP, the held sediment will be analyzed for all Record of Decision (ROD) Table 17 sediment contaminants of concern (COCs).

Note that the historical dataset and the final decision criteria listed in Surface Sediment FSP (for deciding whether or not to analyze for full-suite ROD COCs) are based on laboratory measurement results of grain size and TOC. Laboratory ASTM grain size method uses the #200 sieve, but results are calculated by dry weight and not volume (which is used for field wet sieving). Since sand-size fractions weigh more than silt/clay-size fractions, the lab results will likely be lower. Hence, we recommend relaxing the final criteria described in the PDI Surface Sediment FSP from 35 to 25 percent fines to account for (i) this field/lab measurement difference and (ii) recent lab results of the Oregon Department of Environmental Quality (ODEQ) 2018 data where all samples had less than 30% fines (dry weight).

REFERENCES

AECOM and Geosyntec. 2018. Pre-Remedial Design Investigation (PDI) Surface Sediment Sampling Field Sampling Plan. Portland Harbor Superfund Site, Portland, Oregon. Prepared for the Pre-RD AOC Group for submittal to USEPA Region 10. March 29, 2018.

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ODEQ. 2018. Final Field and Data Report, Upriver Reach Sediment Characterization, Lower Willamette River, Portland, Oregon. Prepared by GSI Water Solutions Inc. and Hart Crowser and prepared for State of Oregon Department of Environmental Quality. May 8, 2018.

LIST OF TABLES

LIST OF FIGURES

Figure 3 – 2018 Interpolated Upriver Areas of Soft Sediment

Figure 4 – Proposed Downtown/Upriver Reach Surface Grab Locations (revised)

Table 1. Field Wet Sieving Results and Visual Estimates of Percent Fines

PDI Upriver Survey Date	River Mile	Probe No.	Water Depth	Field Wet Sieve Volumes (200 mL)		Percent Fines	Pre-Sieve Visual Description
				Fines Passing (< No. 200 sieve)	Fines Remaining (>No. 200 Sieve)		
4/3/2018	17.6 E	58*	5.2	130	50	72%	silt with fine grain sand
	18.9 E	72*	7.5	80	150	35%	poorly graded fine sand with silt
4/4/2018	26.0 W	115	11.8	70	130	35%	poorly graded fine sand, trace woody debris
	25.6 E	113	5.1	75	125	38%	poorly graded fine sand with silt
	24.5 W	126	3.3	120	80	60%	silt with fine grain sand
	24.2 W	130	7.1	20	180	10%	well graded sand trace gravel and some silt
	23.3 W	137	13.1	130	70	65%	silt with some fine sand
	22.8 E	98	4.5	110	90	55%	silt with fine sands and trace organic debris
	20.2 W	153	3.6	130	70	65%	silt with fine sands and trace organic debris
	19.5 W	159	6.3	100	100	50%	silt with fine sand
4/5/2018	19.3 E	77	7.2	100	100	50%	silt with fine sand
	19.2 W	163	6.6	80	120	40%	sand with silt
	18.9 E	72	8.6	100	100	50%	silt with fine sand
	18.7 E	70	9.1	90	110	45%	silt with fine sand
	18.5 W	170	4.8	140	60	70%	silt with trace fine sand
	18.5 E	67	5.9	110	90	55%	silt with some fine sand
	18.2 W	173	6.1	80	120	40%	silt with organic material
	18.0 W	175	6.3	140	60	70%	silt with fine sand and trace organic material
	17.8 E	60	5.5	120	80	60%	silt with some fine sand
	17.4 E	57	5.5	130	70	65%	silt with fine sand
	17.6 W	178	6.2	150	50	75%	silt with trace fine sand
	17.1 W	184	5.8	160	40	80%	silt with trace fine sand
	17.0 E	52	6.3	150	50	75%	silt with trace fine sand
	16.8 E	49	14.2	130	70	65%	silt with trace fine sand
	16.8 W	187	5.9	100	100	50%	silt with fine sand
	16.3 E	45	5.4	90	110	45%	silty sand with trace gravel
	16.0 E	42	4.4	130	70	65%	silt with fine sand and trace organics
	15.7 E	39	13.4	140	60	70%	silt with trace fine sand and trace organic material
	14.9 E	220	11.3	75	125	38%	silty sand with trace organics

PDI Upriver Survey Date	River Mile	Probe No.	Water Depth	Field Wet Sieve Volumes (200 mL)		Percent Fines	Pre-Sieve Visual Description
				Fines Passing (< No. 200 sieve)	Fines Remaining (>No. 200 Sieve)		
	14.5 E	223	9.5	50	150	25%	fine sand some silt and some organic material
	14.2 E	226	15.9	120	80	60%	silt with fine sand and trace oxidized nodes
	15.6 W	197	8.8	90	110	45%	silt with fine sand
	15.4 E	35	5.6	110	90	55%	silt with fine sand
	14.9 E	30	6.8	80	120	40%	sand with silt
	14.9 W	204	12.0	110	90	55%	silt with fine sand
	14.6 E	26	5.4	155	45	78%	silt with trace fine sands
	13.8 W	229	10.3	150	50	75%	silt with trace fine sand and trace organic material
	13.3 W	234	15.3	90	110	45%	silt with trace fine sand and trace organic material
	12.8 E	10	12.9	100	100	50%	silt with fine sand
	12.2 E	5	12.5	140	60	70%	silt with trace fine sand and trace organic material
	12.0 W	236	4.5	150	50	75%	silt with trace fine sand
	11.8 W	238	8.2	150	50	75%	silt with fine sand and trace organic material
4/6/2018	28.3 W	240	10.3	120	80	60%	silt with fine sand, moderate weeds and trace clams
	28.3 W	241	4.3	120	80	60%	silt with fine sand and trace organics
	27.8 W	245	11.3	80	120	40%	fine to medium sand with silt and trace organics
	27.3 W	250	9.8	110	90	55%	silt with fine sand and trace organics
	27.0 W	253	12.5	130	70	65%	silt with some fine sand and trace clams
	26.7 W	257	9.6	160	40	80%	silt with trace fine sand and trace organic material
	26.9 E	260	12.8	120	80	60%	silt with some fine sand and trace organics
	27.4 E	265	10	130	70	65%	silt with some fine sand
	27.9 E	270	10.7	100	100	50%	silt with some fine sand and some organics
	28.3 E	274	10.3	150	50	75%	silt with trace sand and trace organic material

Notes:

* The starting volume for the first two sieves was not 200 milliliters.

Table 2. Percent Distribution of Soft, Medium, and Hard Bottom Areas in the D/U Reach

Area	Area (acres)	Percentage of Entire Area (% of 1,939 acres)
Total D/U Reach	1,939	100%
Mid-Channel Hard Bottom Excluded Footprint	718	37%
Remaining Area (Non-Excluded)	1,221	63%
Remaining Area Classified as Soft Only	478	39%
Remaining Area Classified as Medium Only	243	20%
Remaining Area Classified as Hard Only	477	39%
Remaining Area not Included, Result of Thiessen Polygon Anomalies	23	2%